# What Animal Experimentation or So-called Vivisection Has Done for Humanity.

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Animal experimentation is employed for the purpose of adding to biological knowledge. It is directed to solving the mysteries of life and to aiding man in his mastery of the forces which deteriorate and destroy his body. When the great pioneer biologists showed that man is related to all living things, and that all are governed by the same natural laws, science was put in possession of means for solving human problems by interpreting the phenomena of one species into terms of another species.

The study of human biology was blocked by the traditional belief that man is something peculiar, created independently, cousined to the infinite, permeated by essences which have no relation to animals, and answerable to forces which reside outside of nature and which are not amenable to natural law. When science broke down these superstitions the barriers in the way of biological progress were removed.

The sciences which deal with living matter are now correlated. Protozoa, plants, mollusks, and vertebrates—all have their phenomena interpreted from one to another. Bacteria, plasmodia, and insects are connected intimately with the life of man. The lower vertebrates are found to be susceptible to the same diseases, and resist them by the same vital processes, as man.

It would be strange, indeed, unscientific and unnatural, if man, in quest of information concerning himself, did not take advantage of these great principles. To the credit of science, it can be said that he does.

In every biological laboratory, whether work is done with microscopic organisms or with larger animals, whether the studies are aimed to secure information concerning heredity and breeding, the effects of environment, or resistance to disease, animal experimentation is being carried on. In this line of research, practically all species of living things are employed—vegetable and animal. Among these creatures may be mentioned, as examples, bacteria, plasmodia, flies, mosquitos, fishes, pigeons, rats, guineapigs, cats, dogs, cows, horses, and monkeys,—and even men, for some of the most valuable information which humanity possesses has been secured by self-sacrificing men who have lent their own bodies for experimental purposes.

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I shall not discuss the large field of animal experimentation, dealing with the science of biology in general, nor animal experimentation aimed towards improving and modifying the conditions of animals themselves, altho these represent the larger part of such work; but I shall take out of the subject for special consideration animal experimentation in medicine and hygiene, directed in the physical interest of mankind. Such investigations are in the nature of experiments in breeding, regeneration, feeding, researches in physiology, surgery and hygiene, inoculations with disease-producing micro-organisms to study the nature and cure of diseases, and inoculations for the purpose of producing immunizing substances. The experimental methods consist in the artificial modifications of breeding and feeding, in tests of functions of organs, in inducing diseases, in surrounding animals with artificial living conditions, and in operations. The greatly preponderating number of operations consist in the prick of a needle, introduced for inoculation purposes. A small part of animal experimentation consists in cutting operations.

The cutting operations which are performed upon animals for experimental purposes are few compared with the similar operations which are performed upon human beings for curative purposes. They are in general of the same nature, and carried out in the same way. The experimentor is desirous that the operation should progress smoothly and prove successful. He therefore employs anesthesia and the asceptic methods, and endeavors to surround the animal with the best conditions. The instruments and apparatus of the surgery of the research operator are the same essentially as those of the hospital surgeon.

So far as the personnel of the research workers goes, there is no class of scientists inspired by loftier motives; these men and women represent a high plane of human culture. In days gone by, when humanity was less kind and science was still under the incubus of superstitions, experiments were done which now seem crude and cruel, just as was the surgery of those days—and the theology, for that matter. Every age has its average of culture. At the present time none of these operations upon animals inflict unnecessary pain any more than do operations upon human beings. When one of those rare experiments is done which is bound to leave the animal in suffering, the anesthetic is increased and the animal killed.

In some experiments it is necessary for success that the animal shall be conscious and suffer pain, just as is sometimes the case with operations upon men. These operations are rare. They are rare because the work of animal experimentation is not a business but a scientific philanthropy. The workers, the world over, freely publish the result of their work so that all may have the benefit of what each is doing, and it does not become necessary to repeat experiments. It may be difficult for the

business world to understand this free giving and co-operation. It is the glorious and unique quality of science.

Let us consider briefly some of the results of animal experimentation in contributing to medicine and hygiene.

Physiology, the foundation upon which medicine is built, occupies its high place in science because of animal experimentation. There is not a function of all the organs of the human body but has had light thrown upon it by this means; and many of the functions have been susceptible of discovery only thru such experiments. The actions of organs could not be discovered by the philosopher sitting in his easy chair and meditating about them, nor by the anatomist dissecting organs which had ceased to functionate. They must be observed in action.

The arteries derive their name from the fact that they were found empty after death and were supposed to contain air. Galen learned the truth by a simple experiment upon a living animal. He wrote "Whenever I injured an artery, blood always flowed." He then tied two separate ligatures about an artery, in a living animal, and found that the part of the vessel between them was filled with blood. Harvey, who first gave to the world (1628) a description of the circulation of the blood, said: "When I first gave my mind to vivisections as a means of discovering the motions and uses of the heart, and sought to discover from actual inspection, and not from the writings of others, I found the task so arduous, so full of difficulties, that I was almost tempted to think with Fracastorius, that the motion of the heart was only to be comprehended by God."

The circulation being understood, blood pressure was studied in the horse by Stephen Hales (1727). As a natural result experiments were done to find if in case of hemorrhage the lost blood could not be replaced. Boyle and Lewis bled animals and then introduced blood from other animals into their vessels. The experiments in this line may be followed for two centuries down to the present when Crile, experimenting upon dogs, has so perfected the operation of transfusion that blood may be passed from one person, who can spare it, to another, who needs it, with such certain facility that many lives are now being saved.

Our scientific knowledge of the respiration is founded upon such experiments. Robert Boyle experimented upon rats, frogs, snakes and insects, and showed that atmospheric air was necessary for their existence. Then Priestly discovered oxygen with Lavoisier, and proved the complimentary relation between animals and plants by enclosing a growing plant with a mouse, and demonstrating that the plant consumed the gases which the animal exhaled and the animal consumed that which the plant exhaled. Now man knows that the plants are his allies and that without their purifying effect upon the air he could not survive. By examining the blood in the pulmonary veins and arteries of

animals the gases which are exhaled and inhaled were identified.

So we might go on thru the physiology of digestion and the functions of the liver, pancreas and other glands. The knowledge of the absorption of digested nutriment by the lymphatics dates from the day, in 1662, when Aselli exposed the mesentry of a living dog and saw a network of white lines under the peritoneum running from the intestine, which were never present in a hungry animal.

The whole subject of the internal secretions has been worked out by experimental means. It is thus discovered that the glandular organs supply certain substances to the blood which are essential to the economy. The pancreas, kidneys, ovaries and testicles, not only have their secretions which are discharged externally but internal secretions also. The thyroid, pituitary bodies and suprarenal capsules represent the ductless glands which have their internal secretions only. The destruction by disease or the removal of the organs gives rise to constitutional disturbances. Experiments have shown that it is possible in animals, suffering thus, to restore them to health by transplanting the necessary organs from another animal or by feeding with it. This information is now employed in man with striking results in some of this class of diseases.

The nervous system has been studied by these methods, and research is in progress which is bringing science close to the higher functions of the mind. Before animal experimentation was applied to the brain and nerves, man's conceptions of these were not only lamentable but grotesque. Slowly and patiently the truth has been reached. Paralysis, epilepsy, insanity, and the host of nervous and mental disorders are becoming better understood.

Medicine has been brought out of the dark ages by experimental research. The infectious diseases, which were once assumed to be due to "miasms", "humors" and other vague manifestations of mysterious forces, have in many instances had their causes discovered. Bacteriology and animal experimentation have combined to contribute knowledge of these diseases which is steadily bringing them under subjection. A great branch of science has grown out of these studies—the science of immunity and resistance—and parasitic diseases are now being combated effectively by entirely new means, made possible by animal experimentation.

The most hopeful prophylaxis and treatment of typhoid fever (for the authorities of government seem still unwilling to grasp the social significance of this preventable disease) rests upon the employment of a bacterial vaccine made by Sir Almroth E. Wright, which, after extensive employment in the British Army, has been widely adopted and is now materially reducing the mortality from typhoid.

Tuberculosis also has had its conquest largely contributed

to by these means. Were it not for animal experiments we should still be groping in the dark in dealing with plague. The experimentors have sacrificed thousands of rats and many guinea-pigs, squirrels and fleas in discovering the nature of this disease. Let us see some of the things found out about it. The causative micro-organism, the *bacillis pestis*, has been discovered. It has been found that this organism lives in the blood and lymph channels of rats and certain other rodents. It is also found in the intestinal canal of the flea which infests these rodents. Experiments have shown that it is the flea which carries the germ from the rat to man. Before this knowledge was finally worked out a number of experimentors had sacrificed their lives in the search. Finally a preventive vaccine has been discovered. Of the experimentors some day it will be said, "They stood between the living and the dead, and the plague was stayed."

For cholera, an antitoxic serum has been prepared by experimenting on animals, and is now being used in India with good results.

Diphtheria was once the dread of mothers. It was the great destroyer of the young. Prior to 1883 in the largest eighteen cities in Europe and America, ninety-seven in every one hundred thousand of the population died of this disease; and the mortality was steadily increasing because of the increasing density of population. Then, as a result of experiments, the cause of the disease was discovered. That meant earlier and more certain recognition. The mortality in the same cities, in 1893, had declined to eighty one. In 1894 it was seventy-nine. Then antitoxin, discovered by means of animal experimentation, was introduced, and the mortality from diphtheria in these cities has been reduced to twenty per hundred thousand population. The discovery of the causative organism and of antitoxin has cut down the mortality to less than one fourth of what it had been.

I can remember when surgeons were busy performing tracheotomy upon choking children. Every day I heard of them. Then intubation was hailed with great acclaim. Now the diphtheritic so rarely require these operations that among my own large professional acquaintance I do not hear of such an operation once a year.

In the city of Baltimore, in 1894, the reported mortality from diphtheria was seventy-four per cent.; in 1895, seventy-one per cent.; in 1896, fifty-one per cent. In 1897, antitoxin was introduced, and in the next year, 1898, the mortality was five per cent. In New York City, in 1893, the year before antitoxin was introduced, there were seven thousand cases of diphtheria reported with two thousand six hundred deaths, a mortality of thirty-six per cent. In 1898, the mortality was reduced to twelve per cent.; and in 1906, it was nine per cent. In the seventeen years in which antitoxin has been used in New York, fifty thousand children have been saved from death by this means.

These figures are practically identical with those of London, Berlin, Paris, Liverpool, and other cities. One hundred thousand lives are being saved annually in Europe and America by diphtheria antitoxin. Besides lowering the mortality of the disease, a small injection acts absolutely as a preventive, and the well may be exposed without fear.

Within the past year I contracted virulent diphtheria. The false membrane developed in the upper part of the pharynx, but had not extended to the throat, where it might be seen, until the third day. I played with my children, and after being sent to bed, four of my children repeatedly romped with me. The disease was then identified. Antitoxin was given to every member of the household. The disease was checked. No other cases developed. Twenty-five years ago all of those children would have contracted diphtheria, and two deaths would have occurred.

The conquest of diphtheria has been preceded by years of patient, often discouraging, research; a large number of rabbits and guinea-pigs have been sacrificed, and now many horses are subjected to the inconvenience of receiving an injection of micro-organisms, and having some blood drawn off at certain intervals. These horses in the service of humanity are sleek and well cared for, and take their daily exercise with as much apparent relish as do their richly caparisoned brethren who perform no more useful service than drawing a fluffy dame and a pug-dog thru the park on pleasant afternoons. Society will shortly forget about the scourge of diphtheria, the mothers who have stood by the bedside of choking children will have passed away; but we are near enough to it still to know what it has meant.

Yellow fever was conquered by animal experiments. The animals employed are mosquitos and men. Some day society will erect its monuments to such as Reed, Lazear, Carrol and their associates, the men who have saved, rather than to the warriors whose glory has been in direct ratio to the number of lives which they sacrificed. These men, studying the problem in Cuba, identified a certain species of mosquito as the host of the yellow fever germ. They slept on the bedding where yellow fever patients had died. While the rooms were screened against mosquitos, they were not able to contract the disease. They also allowed themselves to be bitten by mosquitos which had not had access to people suffering with yellow fever, and found that the disease was not transmitted. But one link to complete the chain of evidence remained, would a mosquito that had been fed upon the blood of a yellow fever patient transmit the disease to a healthy man. They believed it would; but positive proof was needed. There was no dearth of volunteers who offered themselves for this final test. Both Carrol and Lazear permitted themselves to be bitten by mosquitos known to be infected. Carrol recovered, Lazear died; Reed and Carrol have since died, exhausted by their labors.

The literature of the world contains no drama more inspiring

than can be read in the letters of the modest, brave and gentle Dr. Walter Reed to his wife, written from the lonesome yellow fever infected camp in Cuba, in the long nights under the tropical skies where he kept the vigil by the bedsides of the men who were laying down their lives that our children might be spared.

The story of malaria is the same. The experiments were performed with mosquitos and the bodies of the experimentors themselves.

Cerebro-spinal meningitis is rapidly brought under control, first by the discovery of the cause, and then by the discovery of an antitoxin worked out at the Rockefeller Institute in New York. The hope of overcoming infantile paralysis lies in the same realm of research. Monkeys are found to be susceptible to the disease; and every effort is being made to secure from these animals information which can be translated for human aid.

Syphilis is one of the most important factors in race deterioration. By means of animal experiments (1) its cause has been discovered, (2) a method for diagnosis has been worked out, and (3) an effective treatment perfected.

Sleeping sickness in six years killed two-thirds of the population of Uganda—two hundred thousand people. Research workers went into plague stricken Africa and discovered the cause of the disease, the mode of transmission, and the means for its prevention. Thousands of lives are being saved annually by this knowledge; but how little does the world know of the work in Africa of Dutton, Todd, Castillani and Bruce, compared with that of General Gordon?

A whole group of diseases of a similar character due to trypanosoma, carried by insects, are now understood. Malta fever, relapsing fever, and yaws, have been studied.

Small-pox was treated by vaccination in remote times, but recently it has been placed upon a more accurate basis by animal experimentation. Experiments upon calves have shown that small-pox virus may be converted into vaccine virus by transmission thru several generations of cattle. Experiments upon calves have resulted in the discovery of methods whereby vaccine may be secured clean and in large quantities. Vaccination for small-pox has brought under control what was once one of the greatest of human scourges.

In London, prior to 1780, one out of every ten deaths was from small-pox. There were five thousand and twenty deaths annually from small-pox to every million of inhabitants. Then vaccination came into use. From 1801 to 1810, the number of deaths per million of population dropped from five thousand and twenty to two thousand and forty; in 1835, it was eight hundred and thirty; in 1871, it was three hundred and eighty-eight; in 1892, it was seventy-two. In all England the death rate from small-pox in 1807 was twenty.

The countries which have the largest proportion of vaccinated population have the lowest mortality from small-pox. These are

Denmark, Norway, Germany and Sweden; and these are the countries which have the most stringent vaccination laws.

In Denmark the death rate from small-pox is 0.5 per million, in Russia it is four hundred and sixty-three per million. In Russia two hundred and seventy-five thousand people annually die of small-pox, who might be saved by vaccination—a culpable governmental sacrifice of human lives.

The effects of vaccination may well be studied in the Philippines. Under Spanish rule, it was necessary during the dry season every year to erect a large temporary hospital at Manila where the many hundred victims of small-pox might be cared for. Over fifty per cent. of the patients died. The six provinces near Manila have a population of about one million people. Dating back as far as records and memory run over 6000 deaths from small-pox occurred every year until vaccination was systematically applied by the United States Government. In 1907 vaccination was completed in these six provinces. Since that time not one person has died at Manila of small-pox who had been successfully vaccinated during the previous five years. Since June, 1909, there has not been a death from small-pox in Manila among any class. Since 1907, in the six provinces, not one person, who had been successfully vaccinated, has died of small-pox and but a few cases have occurred among all classes. Among these few cases not a death took place among those who had ever been vaccinated. This has been the general experience in the vaccinated provinces thruout the islands since the American occupation. The few deaths have been almost entirely among unvaccinated infants and immigrants! (Jour. A. M. A., April 8, 1911; Public Health Reports, March 10, 1911, p. 277.)

The knowledge of myxedema, cretinism, acromegaly, Addison's disease and diabetes have been developed by experiment upon animals.

Rabies (hydrophobia) is one of the most terrible of maladies. It has been observed chiefly among dogs, other domestic animals, and man. It prevails in all countries. It often becomes augmented into an epidemic. The histories of the epidemics are most instructive. Aristotle describes it more than three hundred years before the Christian era. Galen described it with scientific accuracy in the Second Century. A tradition has existed that the disease could develop spontaneously in starving dogs. The first recorded animal experiments were made by Radi and Bourgelat, who failed to cause the disease in hungry dogs. Hertwig inoculated thirty dogs with the saliva of dogs which had died of rabies, or were suffering with the disease, with the result that seventeen of the animals thus inoculated developed rabies. He also made experiments to discover if inoculation could take place thru the food or immediate vehicle, all with negative results. Rabies he found could only be introduced by inoculation into a wound directly from the rabid animal. Experiments are now in progress to discover if fleas can convey the disease from one animal to another.

The most important knowledge concerning the disease was developed by Pasteur. He conclusively proved its infective character, and by great pains succeeded in making a serum which has the power to prevent the development of the disease in an inoculated man or animal. This discovery is saving thousands of lives. Every large city now has a Pasteur Institute where the preventive treatment is carried out. One of our best institutions is the Pasteur Institute in Baltimore, where, of the first one thousand persons treated, six hundred and thirty-two had been bitten by animals which were proved to be rabid by (1) the development of rabies in rabbits inoculated from them, or by (2) the development of rabies in other animals or human beings bitten by them. But two of the patients who completed the immunizing treatment died—a mortality of .2 of 1 per cent. The mortality among persons bitten by rabid animals has been reduced from ten or twenty per cent. to a fraction of one per cent. by means of the treatment worked out by Pasteur's experiments on animals.

Experiments have shown that no dog with rabies lives longer than ninety days. The disease could be stamped out entirely if every dog could be muzzled for that length of time. Australia has no mad dogs because of the application of this knowledge. Denmark, Sweden and Norway have entirely eradicated the disease.

It was Professor Felix von Niemeyer who said that, no one who expends sympathy on the poor dog and petitions against his being tied up or wearing a muzzle, is so inhumane but that he would be cured of his consideration for the poor dog if he could see but one human being with hydrophobia. In England the number of deaths from rabies among dogs and human beings has fluctuated with the enforcement of dog muzzling laws. When dogs were muzzled, rabies diminished; when the authorities listened to the petitions of the so-called "lovers of dogs", and relaxed the muzzling laws, rabies increased.

The disease has spread extensively in the United States. In the registration area in 1908, representing less than half of the country, one hundred and eleven deaths in man due to rabies were reported. This is undoubtedly much less than the real number because of the cases in children which are apt to be overlooked.

We might go on with the enumeration of arterio-sclerosis, snake-bite, hook-worm disease, filarial disease, and most other human ills, and we should find that experiments on animals have contributed greatly to man's knowledge.

Humanity is looking anxiously to this method of research to solve the problem of cancer. In New York State seven thousand people die annually of this disease, and it is believed to be increasing. In England one out of every ten women over thirty-five years of age dies of cancer. Study of the disease made slow progress until it was found that it could be transplanted

upon animals. Now it is studied most successfully in mice by the exact methods of the laboratory. Already means have been discovered for producing immunity in these animals. Mice and dogs may now be cured of cancer. Some of the best scientific minds of the world are devoted to this question. Many observers believe that the solution of the cancer problem is in sight.

The action of drugs and poisons is learned by trying them upon animals. Reliable pharmaceutical manufacturers test their products upon animals. Sir James Y. Simpson learned the action of chloroform by trying it upon rabbits. The action of cocaine was tested in the same way. Is there any better way for science to learn the effects upon living things of new chemical products? The chemist Toynbee first tried prussic acid upon himself, and was found dead on his laboratory floor. That was the expensive method employed to learn that this substance is a poison. How else should we know?

In obstetrics, animal experimentation has resulted in the saving of thousands of mothers annually. In the preaseptic period one married woman in every thirty was destined to die of sepsis at childbirth. Animal experiments made possible an understanding and practical application of asepsis, and childbirth may now be conducted without this hazard.

The same may be said of surgery. To discuss this subject would mean a mentioning of all surgical diseases and operations. The lower animals are subject to most of the surgical ills, and the healing of their tissues is according to the same processes as are observed in man. It would be folly if man's intelligence did not take cognizance of these facts, and if serious operations, which were to be attempted for the first time, should not be practised upon animals instead of men.

Without animal experimentation all new surgical operations amount to vivisection upon man.

Thru experiments upon animals marvellous advancement has been made in the surgery of the nervous system, of the blood vessels, of the intestines and abdomen, of the bones and joints, and all other parts. The surgical infections are better understood; and the practice of surgery approaches close to an exact science.

The infective diseases are not peculiar to species and families of animals alone, but most of them are transmissible to other species and families. Thus the study of the diseases of animals is akin to the study of those of man. Animal experimentation has been brought to bear in combating all of these infections. There is not one but has had its dangers to both man and animal reduced, if not wholly wiped away, by these methods. These things are not accomplished by the student with his books. Scientific work requires contact and experiment with actual things.

Anthrax, hog cholera, chicken cholera, silkworm disease,

Texas fever, pleuro-pneumonia of cattle, trichinosis, black-leg, glanders, etc., have all had their mortality lowered.

Animals and man are not only visited by the same infections, but animals transmit infections from one person to another. Dogs and cats carry contagion from one family to another. There are certain diseases which are known practically only in families which harbor dogs as a part of the household. Koch found tuberculosis present in more than twenty-five per cent. of birds confined in cages in human dwellings. Most monkeys under domestication contract tuberculosis. Flies, fleas, mosquitos, bugs, rats, mice, dogs and cats are the common domestic carriers of disease. These facts are learned only by animal experiments.

This is but a meagre view into the results of this department of scientific work. It is carried on at the present time largely by the experimental biologists. The results accruing are of incalculable value to humanity. The layman uses them, and the physician takes them with him to the bedside of the sick.

Nearly every medical discovery of great importance since Harvey discovered the circulation of the blood has been the direct or indirect result of animal experimentation. The understanding thru such experiments of the nature and of the means of transmission of malaria, yellow fever and other protozoal diseases is the knowledge which is now making the tropics salubrious, and is destined to open up to mankind a half of the land of the world which otherwise would remain scarcely inhabitable. It has helped rob disease, the air, and the soil of many of their mysteries, and aided in breaking down the superstitions which for ages have held mankind in bondage and fear.

Man is the only animal capable of the socialization which sacrifices none of its kind. This is the goal toward which he is tending. About him is a world of living things which prey upon him and upon one another. Some are harmless parasites. Some destroy him and thrive only by his destruction. Some are his allies. Some are indifferent to him. Those which would destroy him, he must contend against. Those which are his allies, he must discover and co-operate with. Life is a battle. Thousands of species have gone down to extinction. New species are appearing upon the field.

Human life should be the supreme object of human interest. Its aim is happiness. Knowledge which adds to this end is the eternal desideratum. To assuage the pains of the human body, to preserve it from decay, to enhance its beauty, to render it more capable of receiving and responding to the stimuli of joy—these are man's duties. The gladness of life rests upon a physical basis. To cast the light of knowledge against the dark places is the function of science; and to hold up the hands of science is the duty of society.